# SCIENCE

NEW YORK, AUGUST 21, 1891.

## THE PRODUCTION OF MUSICAL NOTES FROM NON-MUSICAL SANDS.[1]

THAT I have succeeded in producing musical notes from sand that was never before musical, and am also able to produce similar results from certain mute or "killed" musical sands which have been temporarily deprived of their musical properties, has already been announced in the *Chemical News* (vol. lxiv. No. 1650).

It is not necessary now to give the details of the numerous experiments which led up to this discovery; it will be, perhaps, sufficient for present purposes to state that in November, 1888, I published a paper (read before the Bournemouth Society of Natural Science) in which I propounded a theory to account for the cause of musical sounds issuing from certain sands. After giving various reasons for my conclusions, I said: "It occurred to me, then, that the music from sand was simply the result of the rubbing together of the surfaces of millions of perfectly clean grains of quartz, free from angularities, roughness, or adherent matter in the form of clinging fragments investing the grains, and that these microlithic emissions of sound, though individually inaudible, might in combination produce a note sufficiently powerful to be sensible to us."

Having described numerous experiments, and drawn attention to the hopeful results obtained from the "millet-seed" sand, my paper concluded with the following: "From what I have now told you, I think we may conclude that music may be produced from sand if (1) the grains are rounded, polished, and free from fine fragments; (2) if they have a sufficient amount of 'play' to enable them to slide one against the other; (3) if the grains are perfectly clean; and (4) if they possess a certain degree of uniformity in size, and are within a certain range in size."

On June 20 last I visited Studland Bay for the purpose of carrying out some new experiments. I found that the musical patch emitted tones louder and more pronounced than I had ever heard them before. The best results were obtained by drawing a thick deal rod, on to the end of which I had fixed a resonator, over the surface of the sand; sounds produced in this way were heard unmistakably for a considerable distance. The patch averaged 7¼ yards in width, and ran parallel with the trend of the shore for some hundreds of yards. The sand on the sea side of the patch was fine, and emitted notes of a high pitch; that on the land side was coarse, and emitted notes of a lower pitch. The rod drawn across the patch gave, therefore, a great variety of pitch. Many other interesting facts cannot now be referred to, but it is important to state that some of this sand, when taken off the patch and struck in a box, gave out notes as it did *in situ*. On trying this sand subsequently at home, the coarse emitted distinct notes of a low pitch, but the fine was mute. This was, so far as I know, the first time that the Studland sand had been musical off the patch.

According to my theory, if the number of grains with the polished surfaces could be increased in this fine sand, the number of vibrations would increase also, and so intensify the note, and cause it to become audible; this could only be done, however, by introducing a certain percentage of grains fulfilling the required conditions. To obtain such grains and to introduce them gradually until the necessary number should have been added, would have been a tedious process; and it occurred to me then that the same result might be obtained if the sand were struck in a vessel with a hard and polished interior. I placed, therefore, this fine sand in a teacup, and, on striking it, found that it emitted a high, shrill note (A in *altissimo*), which was far more intense than that given when it formed a part of the patch.

When polished grains of sand are in contact with the sides and bottom of a glazed porcelain vessel, it is obvious that there are numerous points of contact between two polished surfaces, — the sand grains and the vessel, — and that on striking the surface of the sand, the friction necessary to produce the vibrations of a musical note is induced between these points.

This I proved by placing the same sand in various vessels with rough interiors, and by lining these glazed or polished vessels with silk, etc., but in no case would this sand emit notes unless the grains were in direct contact with the glazed or polished surfaces. This peculiarity is not in any way dependent upon the sonorous properties of the vessel used, for it may be "deadened" with impunity, and the note will remain unaltered.

The results of numerous experiments show that musical sand of the Eigg type — i.e., sand possessing in great perfection the physical conditions necessary for the production of music — will be musical in receptacles of whatever composition or form, though in some of these it emits notes "under protest" only.

Those sands which are of the Studland Bay type — i.e., having the necessary physical conditions less perfectly developed, and usually mute except *in situ* — will emit music only in vessels possessing hard and glazed interiors, and, as a rule, of a certain form; while some of the more "sulky" types of sand not only need a vessel of hard and glazed interior, and definite form, but also require a box, or small pedestal of wood (which I call a "coaxer"), on which this vessel must stand before the notes emitted become audible. A "sulky" sand was rendered far more musical by being sifted, washed, and boiled, giving out, after this treatment, notes without the aid of the "coaxer."

After discovering what could be done with such simple apparatus, it occurred to me to try, under similar conditions, some of my abandoned sands — those unmusical sands that had been, during a period of four or five years, treated unsuccessfully for music.

One sand (an iron-sand composed of more or less polished grains, quartz, and much dust formed of denser minerals) gave a very hopeful "swish" (explained in my paper of 1888) in a certain porcelain vessel, and from this — by (1) sifting in sieves, to eliminate the fine material, and to insure uniformity in size of grain; (2) rolling down an inclined plane of frosted glass, to separate the rounded grains from the angular quartz; and (3) boiling in dilute hydrochloric acid, to cleanse the surfaces — I succeeded in producing a sand that, in certain glazed vessels, emits musical notes as clear as those emitted from any of my musical sands but that of Eigg. This sand gives F in *altissimo*, but it soon becomes "killed" because of the fine dust and loss of polish that is the inevitable result of the attrition of the grains. There remains but one thing to be done, and that is to produce a sand which, like that of Eigg, will be musical in almost any receptacle, and I have reason now to think that this will not be very difficult.

It has not been possible here to record more than the merest outline of what has been done, or to give instances of the interesting capriciousness of these sands; it should be understood, however, that no ordinary beach or cliff sand has the slightest inclination to "sing" under any of the "coaxing" methods at present known to me.

[1] Cecil Carus-Wilson, in Nature of Aug. 6.

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IT is stated in *Nature* that Siam, following the example of Japan, is commencing to Europeanize her institutions. The founding of a university has been decided upon, and Professor Haase of Königsberg has accepted the appointment to the chair of physics.

## SEA-SICKNESS.[1]

SEA-SICKNESS is one of those minor miseries of existence for which there appears to be no cure. Many have been loudly trumpeted, but none have really succeeded in susceptible persons. As a matter of fact very little serious study has been given to the subject; persons who do not suffer are apt to despise those who do, and persons who do suffer are too glad to forget their misery to be disposed to give any thought to its source. Professor Rosenbach of Breslau has recently published a small monograph, the outcome of observations and study of the phenomena of sea-sickness extending over ten years. He gives his experiences in the form of a thesis, which he uses as the basis of his explanations and arguments as to the nature of the disease.

His argument of facts is as follows: 1. The malady commences as soon as the vessel pitches, that is, rotates on its transverse axis. 2. The rolling, that is, rotation on its long axis, is less severe, but the combination of the two is very unfavorable. 3. The phenomena appear more quickly and are more severe the farther the patient is from the middle of the ship. Persons sleeping are attacked, also small children and animals. In small boats without sails very sensitive persons may be affected; when sails are used sickness is more likely to occur. 4. A moderate amount of food in the stomach and a small quantity of alcohol is more likely to act as a preventive than an empty stomach. 5. The horizontal position on the deck acts in some degree as a preventive. 6. Anxiety and apprehension precede sickness; a certain exhibition of energy and resolution may in short voyages and with slight vessel motion control the tendency to sickness. Soft winds (for example, sirocco), strong odors, etc., are unfavorable. 7. There are two categories of the affection dependent on individual predisposition; in one the head, in the other the abdomen is principally affected. Cases where both are affected are common.

In regard to intensity: (*a*) Some women begin to feel uneasy from the beginning of the voyage, in perfectly smooth conditions of the surface; they are pale, and have no appetite. There is a certain dread also. It is questionable if they are cases of sea-sickness. Perhaps they represent the purely psychical form. (*b*) In another variety there is a general irritation of the nervous system during the whole voyage. The digestive organs are unfavorably affected. (*c*) This series forms a transitional variety. Slight motions of the vessel affect sensitive persons and produce sickness with general loss of appetite, indisposition to move or speak, and painful sensations in the head or abdomen. These symptoms are a delicate reagent to the disturbing action of the vessel.

As to the theories of the disease, they are arranged under three heads: 1. The psychical theory (so named by the author), according to which all the symptoms are produced through the action of certain sensory organs upon the consciousness, giving rise to uncomfortable or unwonted sensations or disturbed equilibrium. 2. The theory of disturbed equilibrium, according to which the permanent disturbances of equilibrium act as painful irritations to the contents of the skull and of the abdomen, and are thus the causes of the phenomena. 3. The theory of the disturbance of the circulation, according to which the disturbances of equilibrium and the swinging motions of the body produce circulatory disturbances in certain parts.

As regards the psychical theory, the arguments generally adduced in its favor are: 1. That the sight of the pitching vessels and of the up and down motions of the vessel favor the occurrence of sickness. 2. That the abnormal effects do not occur with the eyes shut. 3. That sleepers generally escape. This conclusion the author rejects, for he states that energetic will and closure of the eyes do not quite succeed in warding off the attack.

The action of visual disturbances in inducing the sickness he considers very important, but only secondary as factors in the result. That the sufferers may be roused from sleep in a full paroxysm of the attack; that children at the breast and young children suffer, though less than adults; and that horses, who in their boxes do not see the movements, also suffer — these facts prove, the author states, that the external mechanical influences alone must be the cause of the sickness. These facts, on which the author seems to rely for his conclusions as to the secondary importance of visual disturbances, if in themselves correct, do not appear to demonstrate that visual disturbances were absent in the cases mentioned, and it is to be remarked that in a note the author speaks of closure of the eyes or avoidance of the sight of the mast and bulwarks of the ship as being of great assistance in preventing the attack.

The third theory — that of circulation-disturbances — the author rejects. The second theory is particularly developed, and the disturbing effects of various kinds of unwonted improvement are described and analyzed. Thus, it is shown that backward travelling may produce illness, pains, even vomiting. The motion in swings, the effects of circular motion, are next described. The effects of rapid upward or downward motion have been particularly experimented on by the author in the rapidly-moving American elevators. The author thinks that he has discovered a new and substantial explanation of the action of external movement impulse by the phenomena observed in rapid elevators. It is found that in ascending with the eyes closed, no noise being heard, there is experienced a peculiar feeling at the epigastrium which goes off during the rise, say, of four or five floors, but reappears the moment the elevator stops. The same thing occurs when the elevator moves downwards, the sensation being felt only at the outset and on the arrest of the motion. In the motion of the elevator there occurs a sudden movement and sudden arrest of the movement, and the effect of this in producing the epigastric disturbance is held to be analogous to the effect of the motion observed in the vessel at sea. This explanation furnishes a theory which the author accepts, because it covers the ground to the necessary extent. Further, the author is led to the conclusion that the complex symptoms of sea-sickness are due to the molecular disturbances produced by rapid movements arising from sudden change of direction of the motion, whereby a severe intramolecular shaking and irritation primarily acting on the cells and the protoplasm of particular organs is produced.

The immediate transition from one movement to another movement in a different direction is assumed to be the cause of the disturbances experienced. Thus the painful sensations in sea-sickness, in the act of swinging, in the oscillation liable to occur in rapid railway journeys, agree in this, that the peculiar symptoms of irritation, the distressing feeling at the epigastrium, the cold sweats, the general feeling of illness, and the headache, appear at the moment when the direction of the movement changes.

As regards the cure of sea-sickness, the author considers that the only real cure is "custom." He speaks favorably of certain medicines as being often operative for very short sea voyages — quinine, antipyrine, bromide salts, cocaine, morphine, chloral, and other anæsthetics. He speaks with approval of the advice of older writers that the horizontal position at mid-deck should be taken before the voyage begins, and that a bandage should be tightly placed over the liver, whereby the intensity of the motion is diminished, and a certain degree of fixation of the abdominal contents promoted.

Professor Rosenbach has made a most valuable and suggestive contribution towards the solution of the much-vexed question as to the nature and cause of sea-sickness; and no doubt his views will excite discussion calculated materially to advance our knowledge of the subject.

[1] From the British Medical Journal.

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## DIET AND ANIMAL TEMPERATURE.

A QUESTION has been put to us by a correspondent, says the *Lancet*, whether the animal temperature of persons who subsist on a vegetable diet is lower than that in animal or mixed feeders. The inquiry has never been investigated in the human species on a sufficiently comprehensive scale to be of any value, but such comparative facts as throw light on the matter tend to indicate that vegetable feeders, among the lower creation, have a high temperature. Dr. John Davy, brother of Sir Humphry, and one of our keenest physiological observers of a past day, was among the first to make comparative observations of the temperature of different animals in their normal state; and to a certain extent John Hunter, Pallas, Despretz, and Samuel Metcalfe carried out the same research. In 1869 Dr. B. W. Richardson, in one of h

lectures on experimental and practical medicine, classified the results of most of these previous authors, and tested them by a new series of direct observations. His table of mean results showed that vegetable feeders have a high temperature. The sheep gave a temperature of 104°, the goat of 104°, the pigeon of 108°, and the common fowl 108°. The rabbit showed 103°, while the dog and the cat, animal or mixed feeders, showed 102°. But some herbivora were comparatively low, the ox, for example, 101°, and the horse 100°. The differences here stated were supposed by the last-named observer to depend on the cutaneous covering of the animal more than on any other cause. In the case of the pigeon, on which this author made ninety-four observations, the high temperature was attributed to the non-conducting character of the feathers, a marvellous protection to a swift-flying animal in a cold atmosphere. In man, from 100 observations, he came to the conclusion that in a strictly natural state 98° F. was the truest standard. These researches are useful as comparative studies; still, it is an open question whether in man, or in any species of animal that can live on a mixed diet, there is a variation of temperature according to the mode of diet; and it would be a good work to inquire on a large scale if, under a purely vegetable form of dietary, the temperature in man is reduced. Our correspondent informs us that in him (a healthy man) and in his wife (a healthy woman), both in the prime of life, the temperature now ranges from 96° to to 97.4° F. He for three years and a half, and she for two years and a half, have been total abstainers from alcohol, and have subsisted on fruit and vegetables, with addition of "butter, cheese, milk, eggs, and a little fish." Previously to adopting this system his temperature had never fallen under 98° "in so far as he remembers," and he therefore is inclined to the view that under his new regime he lives as healthily as before, at a lower expenditure of energy. If such prove to be correct, and if it should be demonstrated that a minimum animal diet (for our correspondent, be it observed, is not strictly a vegetarian) will support life efficiently under reduced combustion and reduced waste of material, a valuable as well as curious fact will be added to our practical knowledge. Evidently there is here open a fine field for a patient, perfectly unbiased, and truthful investigator.

## EVOLUTION.[1]

IN the course of that theory of natural science best known to the outer world as that of evolution or development (whereof Darwin was the principal expounder), it becomes necessary for the theorist to endeavor to bridge over the gaps which are very easily to be discerned betwixt existing classes of animals. No doubt geology has supplied not a few of those "missing links," and has undoubtedly proved, for example, how the modern one-toed horse has descended from a four or five toed ancestor; and how birds and reptiles, which every zoologist knows are near kindred, can be linked by at least one fossil bird, which is neither bird nor reptile, but a very decided mixture of both groups. Still, the geological record is an imperfect one, and always will be. If every living thing which had ever existed had been preserved in a fossil state, and had been placed at the disposal of the geologist and anatomist for investigation, there might have been few or no difficulties in the way of piecing together the bits of the puzzle of life. As, however, fossil animals and plants constitute the mere chance preservations of the life that was, we have perforce to be content with a very meagre knowledge of existence in the past ages.

There remains, however, another method of arriving at the relationship which science seeks to show exists between apparently diverse groups of animals and plants. In plain language, when we study the development of an animal or a plant, and see how it works its way from the germ to become the adult form, we are brought face to face with a series of changes and scenes which are significant enough to the thinking mind. Suppose we discover that a frog begins life as a fish, a fact every schoolboy knows, what is the meaning of this strange becoming on the part of that tailless animal? Natural history replies that the frog's development we see to-day is really a recapitulation of its past descent.

[1] Dr. Andrew Wilson, in the Illustrated News of the World.

Witnessing how a tadpole becomes a frog, we are really looking at a moving panorama of the rise and progress of the whole frog-race, whereby that race must have sprung from a fish-like stock, and must have gradually grown into the lung-possessing, air-breathing creatures of the present time. This seems to be the only reasonable interpretation to be placed upon the marvellous changes which we see represented in the development of animals and plants; and this, at least, is the meaning which science attaches to the unfoldings of form and structure discernible in the course of the living being's progress from its beginning, in the egg, to its assumption of its adult character.

In the course of studies in the development of animals, we meet with some very curious discoveries and theories relative to the origin of the various zoological groups; and certain ideas of the origin of backboned animals at large, lately promulgated, seem to be worthy of mention here, as tending to keep us *au courant* with the progress of thought in biology. The puzzle of naturalists has been that of accounting for the origin of the vertebrated animals aforesaid, because these backboned tribes (which range from the fishes to quadrupeds) seem really to stand out very distinctly and by themselves as a specially defined sub-kingdom. The backboned branch of the animal tree, in other words, has presented great difficulties in its being traced to its connection with the parent stem. There is a certain fish, the lowest of its class, called the lancelet, which is found to present, both in its development and in its adult structure, certain close affinities to a lowly tribe of creatures known as tunicates, or sea-squirts. A sea-squirt is simply a kind of animated bag with two openings, somewhat like an ancient "leather bottel," which remains attached to a rock or stone. Hence, from the likeness between the sea-squirt's development and that of the lowest fish, many zoologists are given to regard the former as the putative parent of the vertebrate animals. The sea-squirt, in this view, is the very far-back ancestor (or representative of the ancestor) of the backboned tribes.

More recently, however, certain adventurous spirits in biology have ventilated new ideas of the origin of the backboned forms, and these ideas, I fancy, are more startling even to biological minds (given to feel surprised at nothing whatever) than any previous theories which have been advanced. Seeking for the ancestors of backboned animals among the annelids or worms has not been a process attended by success, in so far as evidence of probability is concerned; but higher in the series of jointed or articulate animals we find the insects, spiders, and crustaceans, of which class the lobster is a fair representative. One scientist declared that for choice he finds the most likely origin of the backboned tribes in the spider-class. What induces this belief is the tendency to head development, among other signs of advance, which the spiders, scorpions, and their allies exhibit. What we call a scorpion's head is really its head and chest united, and a close examination of this region shows that in the arrangement of its nerve-masses, its nerves, sense-organs, and so forth, there is to be traced a very exact resemblance to the similar arrangements in the vertebrate head. Again, it is held that in the development of the scorpion and spider, essentially similar features to those seen in backboned development are to be traced. So that the far-back ancestor of the highest animals, on this belief, are to be sought for in some primitive scorpion, which, getting on in the world, gave origin to the higher group. There might be a difficulty regarding the transition from air to water, from scorpion to fish, no doubt; but I presume it is maintained that out of a common type of primitive breathing organ the modification in question could easily have occurred.

The other theory of vertebrate origin also sees the ancestor of backboned animals in some primitive jointed animal or other. Tracing the development of the backboned brain and spinal cord, an observer regards these important structures as having been formed by the elaboration of jointed nerve-masses placed on the outside of a tube. There is such a tube in the middle of the spinal cord, and this tube extends onwards into the brain. The bold idea has therefore been formulated that the central nervous canal of the backboned tribes represents the digestive tube of the vertebrate ancestor; certain dilatations of the tube in the brain corresponding to the stomach of that ancestor, whose own nervous system (lying

below its digestive tract) has become transformed into the backboned nervous belongings. There is, however, the big liver of the ancestor to be reckoned with. Where has it gone to in the course of the transformation? In the young lamprey it is shown that a kind of temporary liver may be regarded as existing in the brain, and this is looked upon as the rudiment or remnant of the liver which was once the possession of the vertebrate's ancester. On the whole, it may be said, we are getting on very nicely in biological theory; and, whether we accept the views thus set forth or not, we may at least feel some curiosity in knowing how modern speculation is deriving the vertebrates from lower forms, and how the modern backboned animal is thought actually to carry in its spinal cord the remnant of the ancestral digestive system.

## NOTES AND NEWS.

THE Hon. C. B. Farwell of Chicago received a telegram on Aug. 11 from Professor Dyhrenfurth, in charge of the rain-producing experiments provided for by the last Congress, now being conducted on the ranch of Nelson Morris, in Texas. The professor says that the first experiment was made on the 10th, powder being exploded high in the air; and that it rained heavily there on the 11th.

— Mr. F. Howard Collins, the author of a useful epitome of Mr. Herbert Spencer's system of philosophy, has written a pamphlet in which he discusses the causes of the diminution of the jaw in the civilized races. In opposition to the views of Weismann, says *Nature*, he contends that the phenomenon is due to disuse.

— A recent issue of *Nature*, quoting from *Das Wetter* for July, reports a curious case of globular lightning which occurred at Berga, near Schlieben, in Germany, between 3 and 4 o'clock on the morning of July 1. The lightning entered the chimney and split into two parts, one portion running along the rafters of the roof, and the other entering a bed-room occupied by a man and his wife and three children. The man, who was up, on account of the violence of the stôrm, saw the ball jump on to the bedstead, which it broke, and from there it slowly travelled to the opposite side of the room, and disappeared, with a loud crash, through the wall. None of the occupants were injured, further than being deafened for a short time.

— The Vienna correspondent of the London *News*, recalling that paper's description of the Roman remains at Hainburg, about twenty-four miles from Vienna, on the site of the ancient Roman frontier town of Carnuntum, on their discovery a year or two ago, says that new excavations are now taking place in the immediate neighborhood of the Castle of Petronell, the residence of the Counts of Abendsberg Traun, which is about two miles distant from Hainburg, and have resulted in the discovery of many interesting architectural remains and much sculpture. These discoveries lead to the conclusion that Carnuntum must have been a much larger town than was thought, for it seems that it must have contained several hundred thousand inhabitants.

— It is the fashion to write articles on theories of rest and how to obtain it, says the *Illustrated American*. Anna Brackett contributes an admirable paper, entitled "The Technique of Rest," wherein she sets forth the possibilities of absolute rest, both mental and physical, under difficult circumstances. The celebrated Dr. Hammond has also given some very erudite and practical views of the same theme. It would be well for the rushing, hurrying, scurrying, never-resting crowd of workers to stop a moment and listen to such notes of solemn warning; and, at least in the choice of "recreations," to select such diversions as will tend to create exhausted vitality, and not add fresh fuel to a consuming fire. Dr. Hammond lays some stress on the trite truth that rest is often but a change of work. The athlete may rest over a game of chess or whist. The brain-worker of sedentary habit who concentrates a weary mind upon an intricate game which demands unremitting alertness of attention is diverting from his chosen calling just so much mental vigor, — exactly, to an atom, so much vital power. Let those men and women who are thinking for a living stop thinking, as a conscious effort, when they would rest. If she who would plan her life wisely will make a careful estimate of the comparative values of those things which enter into it only by her own consent, offsetting them in the inventory by those demands which are essential, she will draw a pencil through every diversion which is akin to her life-work. If she is a wise journalist or literary woman, she will eschew whist as a wary thief of her powers, whose dangers are even enhanced by her mental habit of self-surrender and concentration.

— Professor Tito Martini of Venice contributes to the issue of the *Rivista Scientifico-Industriale* for the end of June, the results of some experiments on the crystallization of thin liquid films. He finds, according to *Nature*, that a strong solution of sodium sulphate, when cooled to near its saturation point, possesses a viscous character which enables it to form a thin film on a metallic ring, as in Mr. Boys's experiments with soap-bubbles. On rapid evaporation such a film crystallizes to an extremely beautiful open lattice-work of minute crystals, which preserve their transparency for some time, and then effloresce and crumble to powder. The experiments succeeded with rings up to thirty-six millimetres diameter. Similar experiments with ammonium chloride and sodium hyposulphite have hitherto proved unsuccessful. With a transparent film of liquid sulphur, however, even more beautiful results have been obtained. The author regards such experiments, besides being eminently suitable for lecture demonstration, as likely to throw light on the nature of molecular arrangement in relation to crystallization.

— During the last two centuries, says the *Scottish Geographical Magazine*, the Lapps of Norway have been moving gradually southwards, preserving their uncivilized and nomadic mode of life in their new environment. Dr. Yngar Nielsen of Christiania has recently studied this interesting ethnological question (Le Tour du Monde, Nouvelles Géog., p. 137). According to him the southern limit of this people is now marked by the railway from Trondhjem to Östersund, nearly along the 63d parallel of north latitude. To the north of this line are found ancient tombs, places of worship, and names of Lappish origin. Here the Lapps of the present day, though nominally converted to Christianity, retain in secret some of their pagan customs, whereas further south they are good Christians, and have changed even in type. About the year 1600 the southern limit of the Lapps was on the parallel of the northern extremity of the fiord of Trondheim; since then they have made several excursions southward, and have been repeatedly checked by the Norwegian Government. In 1890 they advanced as far as the plateaus of the Hardanger Fjeld. The Norwegians do not resert to violence, but defend their property by legal processes. The question of the Lapp invasion is, however, one that demands the serious attention of the Government.

— In a paper on "Some aspects of Acclimatization in New Zealand," read before the Australasian Association at its Christchurch meeting by Mr. G. M. Thomson, the following remarkable case of hereditary transmission of an apparently defective characteristic was described (New Zealand *Journal of Science*, July). In the district of Strath Taieri, in Otago, some years ago, certain sheep on one of the runs, probably the progeny of a single ram, were found to be evidently short-winded. Apparently the action of the heart was defective, for when these sheep were driven, they would run with the rest of the flock for a short distance and then lie down panting. The result of this peculiar affection was that at nearly every mustering these short-winded sheep used to be left behind, being unable to be driven with the rest. Sometimes they were brought on more slowly afterwards, but if it happened to be shearing time they were simply caught and shorn where they lay. As a result of this peculiar condition a form of artificial selection was set up, the vigorous sheep being constantly drafted away for sale, etc., while this defective strain increased with great rapidity throughout the district, for whenever the mobs were mustered for the market, shearing, or drafting, these "cranky" sheep (as they came to be called) were left behind. This defective character appeared in every succeeding generation, and seemed to increase in force, reminding one of the Ancon sheep referred to by Darwin. At first, of course, the character was not recognized as "hereditary," but as the members of this cranky breed increased to a very

serious extent and spread over the district, it came at last to be recognized as a local variety. When the runs, on which these sheep were abundant, were cut up and sold or re-leased in smaller areas a few years ago, the purchasers found it necessary for the protection of their own interests to exterminate the variety, of which hundreds were found straggling over the country. This was easily and effectually done in the following manner. As soon as a sheep was observed it was pursued, but after running for a couple of hundred yards at a great rate of speed, it would drop down panting behind a big stone or other shelter, and seemed incapable for a time of rising and renewing its flight. It was immediately destroyed, and in this manner a useless, but to the naturalist a very interesting, variety was eliminated.

— M. Paul Barré contributes to the *Revue Française* (April 15, 1891) a short paper on trans-asiatic journeys, from which the *Scottish Geographical Magazine* extracts the following. The Dutchman Ruysbroeck visited Mongolia between 1246 and 1273, but, though he advanced far towards the east, he did not succeed in reaching the Chinese coast. The first European to traverse the whole continent was Marco Polo (1271–1295), who, passing through Turkestan and China, entered Pekin, and extended his journey even to Japan. Irmak Timofeef, a Cossack brigand, opened Siberia to Muscovite influence (1530); and Elisée Bouza (1635), Kopylof (1639), and Sladukhim and Ignatief (1644) succeeded in reaching the north-western limits of this country. Dejnef, in 1648, reached the Gulf of Anadir, and ascertained the existence of a strait between Siberia and America before Behring sailed to that region. Again, Baikof crossed Mongolia in 1654, and entered Pekin as ambassador of the Czar. From this time Russian explorers in Siberia became very numerous, but no one followed in the track of Marco Polo until quite recently. Ney Elias crossed Central Asia in 1872–73; M'Carthy travelled from Shanghai to Bhamo in 1876-78, and thence to the coast; Joseph Martin has crossed Siberia twice; Benoist Méchin and Mailly Chalon journeyed from the Ussuri to Bohkara and Merv; and Przhevalski penetrated as far eastwards as the sources of the Whang-ho. Still more recently (1889) Younghusband traversed Central Asia from Pekin to India, and Bonvalot (1889–90) passed from Siberia through Thibet to southern China.

— On Aug. 13 Gen. Greely sailed for Munich, to attend a meeting of the International Polar Commission. Gen. Greely has been ordered by the War Department to attend this meeting, which is the fourth and final session of the commission, and which completes his work in connection with arctic exploration and scientific investigation of the physics of the polar regions. At this meeting the commission will consider the final scientific treatment of the volumes of physical observations published by the Governments which sent out the expeditions of 1881 to 1883. No less than eleven nations will be represented at Munich. Gen. Greely is the only representative from the United States, having been unanimously elected by the other members of the commission. Gen. Greely, in addition to urging on the commission the general discussion of arctic meteorology, will present to the members a scheme of general treatment for the magnetic observations and results of the studies and investigations of Professor Bigelow of the Nautical Almanac office of the Navy Department. This line of treatment is original, and as it is indorsed by Professor C. A. Schott of the coast survey, the acknowledged authority in this country on magnetics, it is believed that it will be interesting to the scientific world when fully developed.

— The use of the detersive effect of a stream of water, says *Engineering*, has been very general in what is known as hydraulic mining in the western part of the United States, where hills of gold-bearing earth have been washed away by very powerful streams conveyed from elevated sources of water supply in the mountains, the gold being afterwards found in more concentrated form deposited in the valley at points where the current was rapid enough to bear away the earth: but the deposits of earth on the arable lands in the valley below have been so destructive to grazing land that stringent legislation has been necessary to prevent the continuance of this practice in many portions of the country. Recently, however, there has been an application of the same practice, but for a reversed purpose, and that is on a railway line in the State of Michigan, where an available supply of water was used to wash down gravel deposits among trestles or timber viaducts along the line of the road, and in that manner to deposit gravel in such a way as to fill up a solid embankment to the line of the track. By guiding these movable sluiceways and also altering their slope or the supply of the water, the direction and velocity was controlled so as to accomplish the result in a very cheap manner, the expense of such filling being about three cents per cubic yard. At Scranton, Penn., there are numerous piles of anthracite culm in the vicinity of the coal breakers over the pit's mouth at the mines, and recently this material has been put to considerable use under boilers, as people are allowed to take it away at a cost of ten cents per ton. An electric light and power station has been built near one of these culm piles, and the coal taken from the pile to the fire-room by means of a stream of water and a sluiceway. Just outside of the delivery in the fire-room the bottom of the sluiceway is perforated so that the water can pass away, and the fuel is delivered at the fire-room in a reasonably dry condition, as the water passes away from it readily. When the low cost of the fuel and slight expense of its transportation is considered, it is held that the amount of moisture in the fuel is merely an item of lesser expense in comparison with other means of delivery.

— The London *Times* of May 20 gives a melancholy account of the Coreans, extracted from a Japanese paper. An evil genius, says the correspondent, seems brooding over the life of the Corean people, paralyzing every nerve and muscle. This evil genius seems to be nothing else than a wretched system of government, or, rather, the absence of anything deserving the name of government. The aristocracy, by unjust taxation, persecution, and violence, extort from the agricultural population the small surplus of their earnings which remains after their absolute necessities are satisfied. Consequently the villages have a desolate appearance, the roads are execrable, and stagnation prevails throughout the country. Yet the peninsula is remarkably rich in natural products. The gold deposits must be of value, for, even now, gold-dust to the value of about £500,000 is exported yearly. There are rich mines of anthracite in the north, and iron, copper, and lead await the miner and manufacturer. But as long as abject poverty is a man's sole protection the country cannot make progress.

— An interesting article on the utilization of waste products in relation to breweries, in the *Brewers' Guardian* (English), calls attention to the utilization of the carbonic acid gas produced in the fermentation of sugar. On an average, English beer may be considered to contain 5 per cent of alcohol, and as, in the fermentation of sugar, the weight of carbonic acid produced is almost the same as that of alcohol (the exact proportions being 48.9 of carbonic acid to 51.1 of alcohol), there must have been 500,000,000 pounds of carbonic acid produced in our breweries. The specific gravity of carbonic acid is 0.1524, and therefore a simple calculation shows that the above weight is equal to 25,000,000,000 gallons — a volume it is almost impossible to realize. Such a volume would require a space one mile square and forty yards high to contain it. It is now proposed to utilize the greater portion of this large quantity of carbonic acid. The process by which this is to be done has been tried for some little time past in St. James's Gate brewery, Dublin; and Sir Charles A. Cameron has reported very favorably on it. The following are the conclusions at which he arrives after a most careful examination of the process: (1) An immense quantity of carbonic acid is produced in breweries, and is at present wasted; (2) a large proportion of this gas could be condensed to liquid at a cost not exceeding ½d. per pound, but probably less than ¼d. per pound; (3) the process of liquefying the gas is successfully carried on at Guinness's brewery, Dublin; (4) the liquefied gas prepared at Guinness's brewery is perfectly free from any peculiarity of flavor or odor; (5) the carbonic acid produced at soda-water works costs about 4d. per pound; (6) it is safer, and in every way more desirable, to use in beverages carbonic acid derived from a food substance, such as grain, than from mineral sources; (7) the uses of liquid carbonic acid are numerous, important, and increasing.

# SCIENCE:

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Attention is called to the "Wants" column. All are invited to use it in soliciting information or seeking new positions. The name and address of applicants should be given in full, so that answers will go direct to them. The "Exchange" column is likewise open.


## RELATIONS OF TEMPERATURE TO VERTEBRÆ AMONG FISHES.[1]

IT has been known for many years that in certain groups of fishes the northern or cold-water representatives have a larger number of vertebræ than those members which are found in tropical regions. To this generalization, first formulated by Dr. Gill in 1863, we may add certain others which have been more or less fully appreciated by ichthyologists, but which for the most part have never received formal statement. In groups containing fresh-water and marine members, the fresh-water forms have in general more vertebræ than those found in the sea. The fishes inhabiting the depths of the sea have more vertebræ than their relatives living near the shore. In free-swimming pelagic fishes the number of vertebræ is also greater than in the related shore fishes of the same regions. The fishes of the earlier geological periods have for the most part numerous vertebræ, and those fishes with the low numbers (24 to 26) found in the specialized spiny-rayed fishes appear only in comparatively recent times. In the same connection we may also bear in mind the fact that those types of fishes (soft-rayed and anacanthine) which are properly characterized by increased numbers of vertebræ predominate in the fresh waters, the deep seas, and in Arctic and Antarctic regions. On the other hand, the spiny-rayed fishes are in the tropics largely in the majority.

In the present paper, I wish to consider the extent to which these statements are true and to suggest a line of explanation which covers all these generalizations alike.

For the purpose of this discussion we may assume the derivation of species by means of the various influences and processes, for which, without special analysis, we may use the term "natural selection." By the influence of natural selection, the spiny-rayed fish, so characteristic of the present geological era, has diverged from its soft-rayed ancestry.

[1] Abstract of a paper by David Starr Jordan, president of Leland Stanford, Jr., University (Proceedings U.S. National Museum, XIV., 107).

The influences which have produced the spiny-rayed fish have been most active in the tropical seas. It is there that "natural selection" is most potent, so far as fishes are concerned. The influence of cold, darkness, monotony, and restriction is to limit the direct struggle for existence, and therefore to limit the resultant changes. In general the external conditions most favorable to fish life are to be found in the tropical seas, among rocks and along the coral reefs near the shore. Here is the centre of competition. From conditions otherwise favorablè to be found in Arctic regions, the majority of competitors are excluded by their inability to bear the cold. In the tropics is found the greatest variety in surroundings, and therefore the greatest variety in the possible adjustments of series of individuals to correspond with these surroundings.

The struggle for existence in the tropics is a struggle between fish and fish, and among the individuals of a very great number of species, each one acquiring its own peculiar points of advantage. No form is excluded from competition. No competitor is handicapped by loss of strength on account of cold, darkness, foul water, or any condition adverse to fish life.

The influences which serve as a whole to make a fish more intensely and compactly a fish, and which tend to rid it of every character and every organ not needed in fish life, should be most effective along the rocks and shores of the tropics.

For this process of intensification of fish-like characters, which finds its culmination in certain specialized spiny-rayed fishes of the coral reefs, we may conveniently use the term "ichthyization."

If ichthyization is in some degree a result of conditions found in the tropics, we may expect to find a less degree of specialization in the restricted and often unfavorable conditions which prevail in the fresh waters, in the cold and exclusion of the polar seas, and especially in the monotony, darkness, and cold of the oceanic abysses where light can not penetrate and where the temperature scarcely rises above the freezing point.

An important factor in ichthyization is the reduction of the number of segments or vertebræ, and a proportionate increase in the size and complexity of the individual segment and its appendages. If the causes producing this change are still in operation, we should naturally expect that in cold water, deep water, dark water, fresh waters, and in the waters of a past geological epoch the process would be less complete and the numbers of vertebræ would be larger. And this, in a general way, is precisely what we find in the examination of a large series of fishes.

If this view is correct, we have a possible theory of the reduction in numbers of vertebræ as we approach the equator. It should, moreover, not surprise us to encounter various modifications and exceptions, for we know little of the habits and scarcely anything of the past history of great numbers of species. The present characters of species may depend on occurrences in the past concerning which even guesses are impossible.

It may be taken for granted that the ancestry of the various modern types of bony fishes is to be sought among the Ganoids. All the fossil forms in this group have a notably large number of vertebræ. The few now living are nearly all fresh-water fishes, and among these, so far as known, the numbers range from 65 to 110.

Among the *Teleostei* or bony fishes, those which first appear in geological history are the *Isospondyli*, the allies of

the salmon and herring. These have all numerous vertebræ, small in size, and none of them in any notable degree modified or specialized. In the northern seas *Isospondyli* still exceed all other fishes in number of individuals. They abound in the depths of the ocean, but there are comparatively few of them in the tropics.

The *Salmonidæ* which inhabit the rivers and lakes of the northern zones have from 60 to 65 vertebræ. The *Scopelidæ*, *Stomiatidæ*, and other deep-sea analogues have from 40 upwards in the few species in which the number has been counted. The group of *Clupeidæ* is probably nearer the primitive stock of *Isospondyli* than the salmon are. This group is essentially northern in its distribution, but a considerable number of its members are found within the tropics. The common herring ranges farther into the Arctic regions than any other. Its vertebræ are 56 in number. In the shad, a northern species which ascends the rivers, the same number has been recorded.

The sprat and sardine, ranging farther south, have from 48 to 50, while in certain small herring which are strictly confined to tropical shores the number is but 40. Allied to the herring are the anchovies, mostly tropical. The northernmost species, the common anchovy of Europe, has 46 vertebræ. A tropical species has 41 segments. There are, however, a few soft-rayed fishes confined to the tropical seas in which the numbers of vertebræ are still large, an exception to the general rule for which there is no evident reason unless it be connected with the wide distribution of these almost cosmopolitan fishes. In a fossil herring-like fish from the Green River shales, I counted 40 vertebræ; in a bass-like or serranoid fish from the same locality 24, these being the usual numbers in the present tropical members of these groups.

The great family of *Siluridæ* or catfishes seems to be not allied to the *Isospondyli*, but a separate offshoot from another ganoid type. This group is represented in all the fresh waters of temperate and tropical America, as well as in the warmer parts of the Old World. One division of the family, containing numerous species, abounds on the sandy shores of the tropical seas. The others are all fresh-water fishes. So far as the vertebræ in the *Siluridæ* have been examined, no conclusions can be drawn. The vertebræ in the marine species range from 35 to 50; in the North American forms from 37 to 45, and in the South American fresh-water species, where there is almost every imaginable variation in form and structure, the numbers range from 28 to 50 or more.

The *Cyprinidæ*, confined to the fresh waters of the northern hemisphere, and their analogues, the *Characinidæ* of the rivers of South America and Africa, have also numerous vertebræ, 36 to 50 in most cases. I fail to detect in either group any relation in these numbers to surrounding conditions.

In general, we may say of the soft-rayed fishes that very few of them are inhabitants of tropical shores. Of these few, some which are closely related to northern forms have fewer vertebræ than their cold-water analogues. In the northern species, the fresh-water species, and the species found in the deep sea, the number of vertebræ is always large, but the same is true of some of the tropical species also.

Among the spiny-rayed fishes the facts are more striking. Of these, numerous families are chiefly or wholly confined to the tropics, and in the great majority of all the species the number of vertebræ is constantly 24, 10 in the body and 14 in the tail (10 + 14). In some families in which the process of ichthyization has gone on to an extreme degree, as in certain *Plectognath* fishes, there has been a still further reduction, the lowest number, 14, existing in the short inflexible body of the trunkfish, in which the vertebral joints are movable only in the base of the tail. In all these forms, the process of reduction of vertebræ has been accompanied by specialization in other respects. The range of distribution of these fishes is chiefly though not quite wholly confined to the tropics.

A very few spiny-rayed families are wholly confined to the northern seas. One of the most notable of these is the family of viviparous surf fishes, of which numerous species abound on the coasts of California extending to Oregon, and Japan, but which enter neither the waters of the frigid nor the torrid zone. These fishes seem to be remotely connected with the *Labridæ* of the tropics, but no immediate proofs of their origin exist. The surf fishes have from 32 to 42 vertebræ, numbers which are never found among tropical fishes of similar appearance or relationship.

The case of the *Labridæ*, in which the fact was first noticed, has been already mentioned. Equally striking are the facts in the great group of *Cataphracti*, or mailed-cheek fishes, a tribe now divided into several families, diverging from each other in various respects, but agreeing in certain peculiarities of the skeleton. Among these fishes the family most nearly related to ordinary fishes is that of *Scorpænidæ*. This is a large family containing many species, fishes of local habits, swarming about the rocks at moderate depths in all zones. The species of the tropical genera have all 24 vertebræ. Those genera chiefly found in cooler waters, as in California, Japan, Chili, and the Cape of Good Hope, have in all their species 27 vertebræ, while in the single arctic genus there are 31. An antarctic genus bearing some relation to *Sebastes* has 39.

Allied to the *Scorpænidæ*, but confined to the tropical or semitropical seas, are the *Platycephalidæ*, with 27 vertebræ, and the *Cephalacanthidæ*, with but 22. In the deeper waters of the tropics are the *Peristediidæ*, with 33 vertebræ, and extending farther north, belonging as much to the temperate as to the torrid zone, is a large family of the *Triglidæ*, in which the vertebræ range from 25 to 38.

The family of *Agonidæ*, with 36 to 40 vertebræ, is still more decidedly northern in its distribution. Wholly confined to northern waters is the great family of the *Cottidæ*, in which the vertebræ ascend from 30 to 50. Entirely polar and often in deep waters are the *Liparididæ*, an offshoot from the *Cottidæ*, with soft, limp bodies, and the vertebræ 35 to 65. In these northern forms there are no scales, the spines in the fins have practically disappeared, and only the anatomy shows that they belong to the group of spiny-rayed fishes. In the *Cyclopteridæ*, likewise largely arctic, the body becomes short and thick, the backbone inflexible, and the vertebræ are again reduced to 28. In most cases, as the number of vertebræ increases, the body becomes proportionally elongate. As a result of this, the fishes of arctic waters are, for the most part, long and slender, and not a few of them approach the form of eels. In the tropics, however, while elongate fishes are common enough, most of them (always excepting the eels) have the normal number of vertebræ, the greater length being due to the elongation of their individual vertebræ and not to their increase in number.

In the great group of blenny-like fishes the facts are equally striking. The arctic species are very slender in form as compared with the tropical blennies, and this fact, caused by a great increase in the number of their vertebræ, has led to

the separation of the group into several families. The tropical forms composing the family of *Blenniidæ* have from 28 to 49 vertebræ, while in the arctic genera the numbers range from 75 to 100.

The anacanthine fishes in whole or in part seem to have sprung from a blennioid stock. Of these the most specialized group is that of the flounders (*Pleuronectidæ*), already described. The wide distribution of this family, its members being found on the sandy shores of the zones, renders it especially important in the present discussion. The other anacanthine families are chiefly confined to the cold waters or to the depth of the seas. In the cod family (*Gadidæ*) the number of vertebræ is usually about 50, and in their deep-sea allies, the grenadiers or rat-tails, the numbers range from 65 to 80.

Of the families confined strictly to the fresh waters, the great majority are among the soft-rayed or physostomous fishes, the allies of the salmon, pike, carp, and cat-fish. In all of these the vertebræ are numerous. A few fresh-water families have their affinities entirely with the more specialized forms of the tropical seas. Of these the *Centrarchidæ* (comprising the American fresh-water sun-fish and black bass) have on the average about 30 vertebræ, the pirate perch 29, and the perch family, perch and darters, etc., 35 to 45, while the *Serranidæ* or sea bass, the nearest marine relatives of all these, have constantly 24. The marine family of demoiselles (*Pomacentridæ*) have 26 vertebræ, while 30 to 40 vertebræ usually exist in their fresh-water analogues (or possibly descendants), the *Cichlidæ*, of the rivers of South America and Africa. The sticklebacks, a family of spiny fishes, confined to the rivers and seas of the north, have from 31 vertebræ to 41.

It is apparently true that among the free-swimming, or migratory pelagic fishes, the number of vertebræ is greater than among their relatives of local habits. This fact is most evident among the Scombriform fishes, the allies of the mackerel and tunny. All of these belong properly to the warm seas, and the reduction of the vertebræ in certain forms has no evident relation to the temperature, though it seems to be related in some degree to the habits of the species. Perhaps the retention of many segments is connected with that strength and swiftness in the water for which the mackerels are pre-eminent.

The variations in the number of vertebræ in this group led Dr. Günther, nearly thirty years ago, to divide it into two families, the *Carangidæ* and *Scombridæ*. The *Carangidæ* are tropical shore fishes, local or migratory to a slight degree. All these have from 24 to 26 vertebræ. In their pelagic relatives, the dolphins, there are from 30 to 33; in the opahs, 45; in the brama, 42; while the great mackerel family, all of whose members are more or less pelagic, have from 31 to 50. Other mackerel-like fishes are the cutlass fishes, which approach the eels in form and in the reduction of the fins. In these the vertebræ are correspondingly numerous, the numbers ranging from 100 to 160. In apparent contradistinction to this rule, however, the pelagic family of sword-fishes, remotely allied to the mackerels, and with even greater powers of swimming, has the vertebræ in normal number, the common sword-fish having but 24.

The eels constitute a peculiar group of uncertain but probably soft-rayed ancestry, in which everything else has been subordinated to muscularity and flexibility of body. The fins, girdles, gill arches, scales, and membrane bones are all imperfectly developed or wanting. The eel is perhaps as far from the primitive stock as the most highly ichthyized fishes, but its progress has been of another character. The eel would be regarded in the ordinary sense as a degenerate type, for its bony structure is greatly simplified as compared with its ancestral forms, but in its eel-like qualities it is, however, greatly specialized. All the eels have vertebræ in great numbers. As the great majority of the species are tropical, and as the vertebræ in very few of the deep-sea forms have been counted, no conclusions can be drawn as to the relation of their vertebræ to the temperature.

It is evident that the two families most decidedly tropical in their distribution, the morays and the snake-eels, have diverged farthest from the primitive stock. They are most "degenerate," as shown by the reduction of their skeleton. At the same time they are also most decidedly "eel-like," and in some respects, as in coloration, dentition, muscular development, most highly specialized. It is evident that the presence of numerous vertebral joints is essential to the suppleness of body which is the eel's chief source of power. So far as known, the numbers of vertebræ in eels range from 115 to 160, some of the deep-sea eels having probably higher numbers, if we can draw inferences from their slender or whip-like forms; but this character may be elusive.

The sharks show likewise a very large number of vertebræ, 130 to 150 in the species in which they have been counted. In these fishes no comparative study of the vertebræ has been made. The group is a very ancient one in geological time, and in the comparatively few remaining members of the group, the vertebræ, in fact the entire skeleton, is in a very primitive condition. The sharks are free-swimming fishes, and with them as with the eels, flexibility of body is essential to the life they lead.

In some families the number of rays in the dorsal and anal fins is dependent on the number of vertebræ. It is therefore subject to the same fluctuations. This relation is not strictly proportionate, for often a variable number of rays with their interspinal processes will be interposed between a pair of vertebræ. The myotomes or muscular bands on the sides are usually coincident with the number of vertebræ. As, however, these and other characters are dependent on differences in vertebral segmentation, they bear the same relations to temperature that the vertebræ themselves sustain.

From the foregoing examples we may conclude that, other things being equal, the numbers of vertebræ are lowest in the shore-fishes of the tropics, and especially in those of local habits, living about rocks and coral reefs. The cause of this is to be found in the fact that in these localities the influences of natural selection are most active. The production of vertebræ may be regarded as a phase in the process of specialization which has brought about the typical spiny-rayed fish.

These influences are most active in the warm, clear waters of tropical shores, because these regions offer conditions most favorable to fish-life, and to the life of the greatest variety of fishes. No fish is excluded from competition. There is the greatest variety of competitors, the greatest variety of fish-food, and the greatest variety of conditions to which adaptation is possible. The number of species visiting any single area is vastly greater in the tropics than in cold regions. A single drawing of the net on the shores of Cuba will obtain more different kinds of fish than can be found on the coasts of Maine in a year. Cold, monotony, darkness, isolation, foul water,—all these are characters opposed to the formation of variety in fish-life. The absence of these is a chief feature of life in the tropical waters.

The life of the tropics, so far as the fishes are concerned, offers analogies to the life of cities, viewed from the standpoint of human development. In the same way, the other regions under consideration are, if we may so speak, a sort of ichthyological backwoods. In the cities, in general, the conditions of individual existence are most easy, but the competition is most severe. The struggle for existence is not a struggle with the forces and conditions of nature. It is not a struggle with wild beasts, unbroken forests, or a stubborn soil, but a competition between man and man for the opportunity of living.

It is in the cities where the influences which tend to the modernization and concentration of the characters of the species, the intensification of human powers and their adaptation to the various special conditions, go on most rapidly. That this intensification is not necessarily progress, either physically or morally, is aside from our present purpose.

It is in the cities where those characters and qualities not directly useful in the struggle for existence are first lost or atrophied. Conversely it is in the "backwoods," the region most distinct from human conflicts, where primitive customs, antiquated peculiarities, and useless traits are longest and most persistently retained. The life of the backwoods will be not less active and vigorous, but it will lack specialization.

It is not well to push this analogy too far, but we may perhaps find in it a suggestion as to the development of the eels. In every city there is a class which partakes in no degree of the general line of development. Its members are specialized in a wholly different way, thereby taking to themselves a field which the others have abandoned, and making up in low cunning what they lack in strength and intelligence. Thus among the fishes we have in the regions of closest competition a degenerate and non-ichthyized form, lurking in holes among rocks and creeping in the sand, thieves and scavengers among fishes. The eels fill a place which would otherwise be left unfilled. In their way, they are perfectly adapted to the lives they lead. A multiplicity of vertebral joints is useless to the typical fish, but to the eel strength and suppleness are everything, and no armature of fin or scale or bone so desirable as its power of escaping through the smallest opening.

It may be too that, as rovers in the open sea, the strong swift members of the mackerel family find a positive advantage in the possession of many vertebræ, and that to some adaptation to their mode of life we must attribute their lack of ichthyization of the skeleton. But this is wholly hypothetical, and we may leave the subject with the general conclusion that with the typical fish advance in structure has specialized the vertebræ, increased their size and the complexity of their appendages, while decreasing their numbers; and that, with some exceptions and modifications, this reduction is characteristic of fishes in the tropics, and that it is so because in the tropics the processes of evolution are most active, so far as the fishes are concerned.

## LETTERS TO THE EDITOR.

**** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

*On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.*

*The editor will be glad to publish any queries consonant with the character of the journal.*

### Fair-Weather Echoes.

MY dog, a deep-voiced Newfoundlander, has one plague in life — an echo. It comes from a cottage some three hundred yards off, and there that "other dog" will always have the last word. This is exasperating, and "Graph"—he is named after another sound-producer, the graphophone — gives vent to his anger in a series of short, sharp, threatening yelps, which are of course more distinctly reproduced than the long bow-wows and howls. Last night Graph was very noisy, but the echo was silent. I tried to rouse it, and excited Graph to do his utmost, but with no effect. A moderate, even-down rain was falling, and the fair-weather echo would not venture out. There is, of course, a reason for this, but I had never noticed the fact before. Is the explanation that the lines of rain cut through the aerial sound-waves and stop them? Are echoes among the hills interfered with by rain?

When the shower was over I tested the echo again, and there it was, a little fainter than usual, but persistent as ever.

A. M. B.

Colonial Beach, Va., Aug. 13.

### Number of Words in an Ordinary Vocabulary.

IN examining the vocabularies of children, my interest in the size and nature of the vocabulary of an ordinary person, previously aroused by the varying statements and estimates I have seen, was excited sufficiently to induce me to spend a portion of my vacation in making some investigations, the results of which may be of interest to the readers of *Science*.

I first turned to Webster's Unabridged Dictionary (edition of 1870), and counted the words on every twenty-fifth page, and found the percentage of them whose meaning was known to me. Then by calculation I found that if the same percentage holds for the other pages I must know the meaning of nearly seventy thousand of the words given in that edition of the dictionary. Since in the dictionary a word as a transitive verb, as an intransitive verb, as a noun, as an adjective, as an adverb, is separately defined, as well as when used with a prefix, a suffix, or in a compound; and since the irregular plurals, adjectives irregularly compared, and the parts of irregular verbs are also given, this number is perhaps twice that of the really different words. The meaning of some of these words was readily divined from their form, although they had never been seen. On the other hand, one word not unfrequently has a dozen different shades of meaning, several of which often require as different and definite associations as entirely distinct words. Hence the effort required to learn all of these words, with their different shades of meaning, but similar form, is probably as great as it would be to have seventy thousand different words, each having but one meaning. I did not understand the meaning of all of the words well enough to define and use them with accuracy, but merely well enough to grasp their meaning in any sentences in which they might be used, and I probably have never actually used a fourth of them. But, besides the words in the dictionary and some new words given in later editions, and a number of words and phrases from other languages in common use, there are probably several thousand proper names, such as are found in history, geography, fiction, and among acquaintances, each with its distinct associations, familiar to every intelligent person. These words will more than make up for any error in counting that I could have made.

Professor E. S. Holden (Trans. Philol. Soc., 1877), found his own vocabulary to be between thirty-three and thirty-four thousand words, and estimated that of an ordinarily intelligent person at twenty-five thousand. I do not know what he called a word, nor whether he counted as known words that he could not or did not use. He estimates that the vocabulary of technical terms possessed by a specialist may reach ten thousand or more. In "Gray's Structural Botany" there is a glossary of between two and three thousand technical terms, the vast number used in cryptogamic botany not being included in the list, and of course none of the special names of plants, so it is not improbable that a well-read botanist may have a technical vocabulary of ten thousand words, and a zoologist a greater number.

The words in common use by the ordinary individual has been estimated at from one to three thousand, and it is claimed that when one has learned the meaning of that many words he can carry on any ordinary conversation or understand common, gen-

eral reading. It is also frequently stated that the vocabulary of certain miners consisted of but one hundred words. Whether this was an actual count or merely an estimate I do not know, but should think that it must be the latter. In order to determine the size of an ordinary vocabulary I could think of no better means than to find out the number of words used in some standard work that is easily read and understood by everybody. Nor could I think of any book better suited for the purpose in view than that great English classic, "Robinson Crusoe." The copy of that work in my possession contains 460 pages, and I first noted down all of the different words found on every tenth page (counting as a separate word what is given as such in the dictionary). This probably gave more different words than forty-six consecutive pages would have done, because a greater number of subjects and incidents are discussed and described. I then noted the new words on the remaining nine of a section of ten pages in the front part of the book, and then of a section in the latter part, in order to get a basis for estimating the new words in the rest of the book. The number of words on the sixty-four pages counted was thirty-one hundred, and if the percentage of decrease for each section of nine pages from the section counted just before it should be the same as for the two sections counted, there would be on the remaining 396 pages about three thousand words. It may be, as would seem probable, that the percentage of decrease would increase after awhile, but so far as counted there was no sign of an increased rate of falling off. The falling off was very rapid for the first five pages, less rapid for the next twenty, and after that not enough to be evident unless the average of a number of pages was taken. It seems quite certain, then, that De Foe, in writing his account of the adventures of Robinson Crusoe, used not less than five or six thousand words. Children of ten or twelve years read the book with pleasure, and probably have a pretty clear idea of the meaning of nine out of ten of the words they find in it. The work probably contains most of the verbs and a large proportion of the adjectives and adverbs in common use, but there is a large number of nouns, both common and proper, familiar to every child, which De Foe had no occasion to use in this work. It is probable then that to read ordinary general reading in English understandingly one needs to be familiar with from six to ten thousand words. The same must be true for other languages equally rich in synonymes. Grimm's "Märchen" contains a vocabulary of between four and five thousand words, yet any one who can readily read those stories needs a dictionary constantly by his side when reading ordinary German.

From the data at hand I should estimate the vocabulary of a citizen of the United States with a common-school education and of ordinary intelligence and reading at about ten thousand words, and that of a well-read college graduate, and of those who have pursued a university course, at from twenty thousand upwards to perhaps one hundred thousand. One's vocabulary is usually nearly complete at thirty years of age. If but two words are learned each day the vocabulary at that age would be only twenty thousand. My records show that young children acquire new words more rapidly than that.

As to the composition of a vocabulary, I find that in the dictionary about 60 per cent of the words are nouns, a little over 22 per cent adjectives, and a half that per cent verbs, and a fourth adverbs. Pronouns, prepositions, and conjunctions, though used in every sentence, constitute a very small part of a general vocabulary — none were found in examining fifteen pages, or one in every hundred, in the dictionary. Of the thirty-one hundred words obtained from "Robinson Crusoe," a little over 45 per cent were nouns, 24 per cent verbs, a little over 17 per cent adjectives, and 7 per cent adverbs. Probably nearly every one is familiar with a larger proportion of the verbs than of the nouns in the dictionary, but "Robinson Crusoe" is particularly rich in verbs. Many of them are used only as participles, the form in many cases being the same as for the adjectives, but they only counted as verbs unless distinctively used as adjectives. As already suggested, the ordinary vocabulary contains a larger proportion of nouns than are found in "Robinson Crusoe," and many that are not found in the dictionary, although the proportion is probably not greatly different from what it is in the latter. In small vocabularies the proportion for the different parts of speech is quite different. Of the 215 words on the first page of "Crusoe" that I counted, 5 per cent were prepositions, 10 per cent adverbs, 10 per cent pronouns, 6 per cent conjunctions, and but 24 per cent nouns. This must be borne in mind in considering small vocabularies like those of children.

As a matter of some general interest, and a point of considerable importance, in considering the question of the pronouncing vocabulary of children, it is worth while to notice with what letters of the alphabet the greatest number of words begins. The letters s, p, and c begin nearly one-third of the words in the English language. The following is the order for the letters most frequently used in the dictionary: s, p, c, a, t, b, r, m, d, f, e, h, l, g, w, o, v, n, u; in "Robinson Crusoe," s, c, p, a, f, b, r, m, e, t, w, h, l, i, g, o, n, u, v.

Further data are needed in order to confirm or correct the estimates given in this article. E. A. KIRKPATRICK.

Rhodes, Iowa, Aug. 14.

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## Climatic Changes in the Southern Hemisphere.

HAVING had occasion to cruise a considerable time over the Southern Ocean, I have had my attention directed to its prevailing winds and currents, and the way in which they affect its temperature, and also to the ice-worn appearance of its isolated lands.

It is now generally conceded that the lands situated in the high latitudes of the southern hemisphere have in the remote past been covered with ice-sheets, similar to the lands which lie within the antarctic circle. The shores of southern Chili, from latitude 40° to Cape Horn, show convincing evidence of having been overrun by heavy glaciers, which scoured out the numerous deep channels that separate the Patagonian coast from its islands. The Falkland Islands and South Georgia abound with deep friths; New Zealand and Kerguelen Land also exhibit the same evidence of having been ice-laden regions; and it is said that the southern lands of Africa and Australia show that ice accumulated at one time to a considerable extent on their shores. At this date we find the southern ice-sheets mostly confined to regions within the antarctic circle; still the lands of Chili, South Georgia, and New Zealand possess glaciers reaching the low lands, which are probably growing in bulk; for it appears that the antarctic cold is slowly on the increase, and the reasons for its increase are the same as the causes which brought about the frigid period which overran with ice all lands situated in the high southern latitudes.

Why there should be a slow increase of cold on this portion of the globe is because of the independent circulation of the waters of the Southern Ocean. The strong westerly winds of the southern latitudes are constantly blowing the surface waters of the sea from west to east around the globe. This causes an effectual barrier, which the warm tropical currents cannot penetrate to any great extent. For instance, the tropical waters of the high ocean levels, which lie abreast Brazil in the Atlantic and the east coast of Africa in the Indian Ocean, are not attracted far into the southern sea, because the surface waters of the latter sea are blown by the westerly winds from west to east around the globe. Consequently the tropical waters moving southward are turned away by the prevailing winds and currents from entering the Southern Ocean. Thus the ice is accumulating on its lands, and the temperature of its waters slowly falling through their contact with the increasing ice; and such conditions will continue until the lands of the high southern latitudes are again covered with glaciers, and a southern ice period perfected. But while this gathering of ice is being brought about, the antarctic continent, now nearly covered with an ice-sheet, will, through the extension of glaciers out into its shallow waters, cover a larger area than now; for where the waters are shoal the growing glaciers, resting on a firm bottom, will advance into the sea, and this advancement will continue wherever the shallow waters extend. Especially will this be the case where the snowfall is great.

Under such conditions, it appears that the only extensive body of shallow water extending from the ice-clad southern continent

is the shoal channel which separates the South Shetlands from Cape Horn, which is a region of great snowfall. Therefore should the antarctic ice gain sufficient thickness to rest on the bottom of this shallow sea it would move into the Cape Horn channel and eventually close it. The ice growth would not be entirely from the southern continent, but also from lands in the region of Cape Horn. Thus the antarctic continent and South America would be connected by an isthmus of ice, and consequently the independent circulation of the Southern Ocean arrested. Hence it will be seen that the westerly winds, instead of blowing the surface waters of the Southern Ocean constantly around the globe, as they are known to do to-day, would instead blow the surface waters away from the easterly side of the ice-formed isthmus, which would cause a low sea-level along its Atlantic side, and this low sea-level would attract the tropical waters from their high level against Brazil well into the southern seas, and so wash the antarctic continent to the eastward of the South Shetlands.

The tropical waters thus attracted southward would be cooler than the tropical waters of to-day, owing to the great extension of cold in the southern latitudes. Still they would begin the slow process of raising the temperature of the Southern Ocean, and would in time melt the ice in all southern lands. Not only the Brazil currents would penetrate the southern seas, as we have shown, but also the waters from the high level of the tropical Indian Ocean which now pass down the Mozambique Channel would reach a much higher latitude than now.

The ice-made isthmus uniting South America to the antarctic continent would, on account of its location, be the last body of ice to melt from the southern hemisphere, it being situated to the windward of the tropical currents and also in a region where the fall of snow is great; yet it would eventually melt away, and the independent circulation of the Southern Ocean again be established. But it would require a long time for ice-sheets to again form on southern lands, because of the lack of icebergs to cool the southern waters. Still, their temperature would gradually lower with the exclusion of the tropical waters, and consequently ice would slowly gather on the antarctic lands.

The above theory thus briefly presented to account for the climatic changes of the high southern latitudes is in full accord with the simple workings of nature as carried on to-day; and it is probable that the formation of continents and oceans, as well as the earth's motions in its path around the sun, have met with little change since the cold era iced the lands of the high latitudes.

At an early age, previous to the appearance of frigid periods, the ocean waters of the high latitudes probably did not possess an independent circulation sufficient to lower the temperature so that glaciers could form. This may have been owing to the shallow sea-bottom south of Cape Horn having been above the surface of the water, the channel having since been formed by a comparatively small change in the ocean's level. For, while considering this subject, it is well to keep in mind that whenever the western continent extended to the antarctic circle it prevented the independent circulation of the Southern Ocean waters, consequently during such times ice periods could not have occurred in the southern hemisphere.

It will be noticed that according to the views given above, the several theories which have been published to account for great climatic changes neglect to set forth the only efficacious methods through which nature works for conveying and withdrawing tropical heat sufficient to cause temperate and frigid periods in the high latitudes. While lack of space forbids an explanation of the causes which would perfect an ice period in the northern hemisphere, I will say that it could be mainly brought about through the independent circulation of the arctic waters, which now largely prevent the tropical waters of the North Atlantic from entering the arctic seas, thus causing the accumulation of ice sheets on Greenland. But before a northern ice period can be perfected, it seems that it will need to co-operate with a cold period in the southern hemisphere; and in order to have the ice of a northern frigid period melt away, it would require the assistance of a mild climate in the high southern latitudes.

C. A. M. TABER.

Wakefield, Mass., Aug. 14.

## BOOK-REVIEWS.

*The Journal of the College of Science, Imperial University of Japan.* Vol. IV., Part I.

THIS volume forms a fitting complement to the numbers already issued, and indicates the advanced position of the college and the high standing of its teachers and special students. If any thing would commend an institution to the generous attention of the government it is the admirable work which has been embodied in the various memoirs of the series. The present number opens with a memoir by Professor K. Mitsukuri on the "Fœtal Membranes of Chelonia." It is one of a series on the embryology of *Reptilia*. The first one, in which Mr. Ishikawa was joint author, was on the germinal layers of Chelonia. The fœtal membranes of *Reptilia* have been supposed to bear a close resemblance to those of birds. Mr. Mitsukuri has found many notable features which have, hitherto, been overlooked, and these appeared so remarkable that he has made them the subject of his memoir. Ten beautiful plates accompany the text.

Mr. Kamakichi Kishinouye gives the results of his researches on the "Development of the Araneina," illustrated by four plates. The material for study was obtained on the grounds of the university, and this included *Lycosa*, *Agalina*, and other genera of spiders. His method of treating the eggs is given in full, and will be found of great value to the student. His discussion of the formation of the pulmonary lamellæ or lung-book is very interesting. He thinks it probable that the lung-book was derived from the gills of some aquatic arthropodous animal, such as Limulus, comparing it with the lamellar branchia of Limulus sunk beneath the body surface. He shows that an invagination of the first abdominal appendage gives rise to the lung-book, and a similar invagination at the base of the second gives rise to a tube—abortive trachea. Many other interesting points are developed or sustained in this memoir.

Mr. Oka has a memoir on a new species of fresh-water polyzoa, *Pectinatella gelatinosa*. His methods of preparation will be found valuable to students of this group. His allusions to the views of Hyatt and Morse as to the anterior region of the polypidæ refer to views uttered over twenty-five years ago, when the polyzoa and brachiopods, with the tunicates, were supposed to be molluscan. These views are antiquated, and have long since been abandoned by the authors in question. Circulation is showed by Oka to be by ciliary action. He confirms Verworn in showing ciliary action on the external wall of the alimentary canal. Important observations are made on a pair of excretory organs which are ciliated and communicate with the epigastric cavity by wide openings. Their external openings have not been found, but the relation these bear to the segmental organs of brachiopods and worms seems unquestionable. An exhaustive discussion is given to the development of the statoblast, and the longitudinal sections depicted are of great value. The memoir is a solid contribution to the literature of this interesting group of animals. Four plates illustrate the details of anatomy and development.

Mr. Seitaro Goto has a memoir, with three plates, on a new form of Diplozoon, to which he gives the specific name of "nipponicum." He gives reasons for separating it from the single species known as paradoxum. The curious creature is described in detail, and interesting points are added to what has already been known.

A new species of hymenomycetous fungus injurious to the mulberry tree, illustrated by four plates, is described by Mr. Nobujiro Tanaka, with a discussion of this fungus, which has caused much destruction of the mulberry tree in Japan.

Notes on the irritability of the stigma, by Mr. Miyoshi, are illustrated by two plates. The author shows conclusively that this irritability, as Hermann Müller first suggested, has to do with the cross-fertilization of the flower, and is not for protection against wind and rain. Irritability is excited by an insect or a bristle, and not by a drop of water or by blowing against it.

Notes on the development of the suprarenal bodies in the mouse, with two plates, are by Mr. Masamaro Inaba. In this paper is discussed the mode of origin of the two substances which go to make up the suprarenal bodies. He comes to the conclusion that

the cortical cells are derived from the peritoneal epithelium, as stated by Janosik; and the medullary substance from the sympathetic elements, as described by Professor Mitsukuri.

In these various memoirs the authors express their indebtedness to Professors Mitsukuri, Iijima, and Yatabe for aid and advice. The plates are marvels of beautiful lithography, and the drawings are made with that skill and accuracy which characterize all their work.

*Taxidermy and Zoölogical Collecting.* By WILLIAM T. HORNADAY. New York, Scribner. 8°. $2.50.

WHO the author of this work is, is certainly well known to most of the readers of *Science*. For years he has been connected with the National Museum as the chief taxidermist, and for a long time previously he was the taxidermist of a prominent natural science establishment. So it is with regret that we learn that Mr. Hornaday is to retire entirely from taxidermy forever. But associated with the chief author of the book was Dr. W. J. Holland, who supplied the chapters on collecting and preserving insects.

The considerable popular interest in zoölogy, and the great numbers of young naturalists coming forward, give reason to suppose that the book will meet with a considerable demand, especially as there is no other book of equal scope available.

The author urges on those who care for the preservation of specimens of many forms of animal life that they must be up and doing. It is already too late to collect wild specimens of the American bison, California elephant seal, West Indian seal, great auk, and Labrador duck. Very soon it will be impossible to find walrus, manatee, fur seal, prong-horn antelope, elk, moose, mountain sheep, and mountain goat. Then ducks are being rapidly exterminated for market, and numerous birds for the sake of fashion.

The first part of the book is on collecting and preserving. This is by no means an unimportant part of the whole, occupying nearly one hundred pages, and covers every part of the work of collecting zoological specimens, even to birds' eggs and nests.

Taxidermy is treated in the second part, which occupies one hundred and fifty pages. This opens with an account of the worker's laboratory, and closes with hints as to the most effective ways of "making up" the finished specimen, for they must resort to paint as well as some other faded beauties.

There are then a number of pages devoted to the making of plaster casts. This makes the third part of the book, which is followed by the part (IV.) devoted to osteology, or at least so much of it as can be applied in the collecting and mounting of skeletons.

The closing chapters are on insect collecting, by Dr. Holland. The book is liberally illustrated, credit being given by the author to Mr. Frederick A. Lucas for much assistance in this feature.

## AMONG THE PUBLISHERS.

THE *Chautauquan* for September presents the following among other articles in its table of contents. "Russia and the Russians," by Mrs. C. R. Corson (illustrated); "The American Association for the Advancement of Science," by Marcus Benjamin; "What

Shall the Boy Take Hold of?" by Theodore Temple; "Modern Methods of Social Reform," by Lyman Abbott; "The United States as a Publisher of Scientific Books," by J. Howard Gore; "The Hawaiians," by Professor J. N. Ingram; and "Washington a Literary Centre," by Ellen Hardin Walworth.

— W. B. Harison of 3 East 14th Street, New York, announces the fifth edition of "A Manual of Land Surveying," by F. Hodgman and C. F. R. Bellows. This handy pocket volume of nearly five hundred pages contains, besides an elementary course of practice with instruments, a treatise upon the survey of public and private lands, and is adapted to the use of schools us well as of surveyors.

— D. C. Heath & Co., Boston, will issue this month "Folk and Fairy Tales in French for Young or Old Children," selected and edited, with notes and vocabulary, by Professor E. S. Joynes of the University of South Carolina. The edition will contain a number of favorite fairy tales by Perrault, Mme. d'Aulnoy, etc., offering easy and entertaining reading, with notes and vocabulary. They will also issue this month Andersen's "Bilderbuch ohne Bilder," an illustrated edition, with notes and vocabulary, by Dr. Wilhelm Bernhardt.

— Ginn & Co. announce "Talks with Young People about the Wonders of the Heavens," by Sir Robert S. Ball, F.R.S., Royal Astronomer of Ireland, illustrated. This book is based upon two courses of Christmas lectures delivered to children at the Royal Institution, Great Britain, and presents the fundamental facts and ideas of astronomy.

— The recently completed fifth edition of Dr. M. Foster's well-known "Text-Book of Physiology" will be followed at once by the appearance of a sixth and cheaper edition of the work, in parts, carefully revised throughout by the author. The addition of much new matter to this edition of the book will permit of taking out a copyright on the American edition, which is to be published by Macmillan & Co., New York.